IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Z. Abdullah et al. Attorney Docket No.: WEYE122140/24766A

Application No.: _____

Filed: Concurrently herewith

Title: REFRACTORY VESSEL AND LINING THEREFOR

PRELIMINARY REMARKS

Seattle, Washington 98101

January 13, 2004

TO THE COMMISSIONER FOR PATENTS:

INTRODUCTORY COMMENTS

These are preliminary remarks to accompany a continuation application based on Serial No. 10/095,269, filed March 11, 2002 (the "parent application").

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REMARKS

This preliminary amendment is filed in connection with the above-identified new application. This application is a continuation application based on prior Application Serial No. 10/095,269, filed March 11, 2002 (the "parent application"). In the parent application, two claims were found allowable. Those claims were placed in independent form in an Examiner's Amendment. The remaining claims were canceled to obtain an immediate allowance of the allowed claims. The Examiner indicated that the prior arguments submitted by the applicants also overcame the prior rejections of the remaining claims; however, he had found a new reference, Hyde (U.S. Patent No. 3,528,647), which he felt would need to be applied against the remaining claims.

Those remaining claims now appear in this continuation application as Claims 1-6. The Examiner is asked to note that each of the independent Claims 1, 2, and 5 are limited to a selectively crushable material positioned in the gap between a refractory liner and a metal shell. The crushable material has a predetermined yield stress that will provide controlled resistance to the expansion of the refractory liner resulting from chemical growth of the liner itself caused by the reaction of chemicals with the refractory liner.

By way of background, prior art refractory vessels are lined with conventional refractory materials comprising alumina. These refractory materials are subject to conventional thermal expansion in both the radial and vertical direction when heated by the chemical reaction occurring inside the refractory vessel. When the chemical reaction is the burning of black liquor to produce combustible gases, it has been found that the refractory materials deteriorate and spall, and must be replaced much more often than in conventional refractory applications. The inventors have found that this is caused by the chemical reaction of the sodium in the black liquor with the alumina. This reaction forms sodium aluminate. Sodium aluminate occupies a

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volume that is approximately 130% that of the original alumina. This causes an actual growth and expansion of the refractory materials. This chemical expansion can overstress the outer shell of the refractory vessel and, at the same time, force inward movement of the refractory materials. As it moves upon itself in a radial inward direction the innermost portions of the refractory material are compressed on itself. As a result, excessive spalling, cracking, and breaking occur in the refractory material. This requires the broken material to be removed from the refractory vessel on a periodic basis (normally daily), and also requires complete replacement of refractory material on an annual basis.

Hyde basically discloses a fiber blanket used to accommodate thermal expansion of the brick lining. In addition, a sacrificial flammable wood material may be placed behind the hot brick. This flammable layer would burn away providing a gap into which the bricks may expand due to thermal expansion. Use of both of these techniques is recognized and is well known in the prior art. In fact, both were employed in previous liners used in black liquor gasifiers (pressure vessel) which led to the failures pointed out above and furthermore led to the present invention. In the prior gasifiers, a one-half inch thickness of composite blanket was also used. This prior art technique, as exemplified by Hyde, does not work in the context of a refractory liner that expands significantly due to chemical expansion (as opposed to conventional thermal expansion). The prior art materials taught by Hyde do not provide controlled resistance to expansion of the liner. Any resistance to expansion by the prior art materials would be *de minimus*.

The prior art materials techniques do not work in the context to the applicants' invention for the following reasons:

1. Expansion due to chemical reaction of the refractory material from alumina to sodium aluminate is much larger than that due to ordinary temperature increase of the brick. The

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thermal expansion coefficient for fused cast alumina is $8x10^{-6}$ per degree centigrade. Assuming a ΔT of 1000°C, the linear thermal expansion is about 0.8%, which gives a volume thermal expansion on the order of 0.5%. The Oakridge National Laboratory reports, on the other hand, that the volumetric expansion related to chemical change from alpha alumina to sodium aluminate, the kind of expansion that applicants herein have learned to contain, is approximately 25%, and from beta alumina to sodium aluminate of about 18%. Thus, applicants have learned to accommodate chemical expansion which is on the order of 36 to 50 times that normally observed with conventional thermal expansion.

2. The second reason the prior art will not work is that fiber blankets are extremely soft materials. They feel similar to the blankets everybody uses at home. These materials do not provide the necessary resistance to the radial outward displacement of the bricks caused by chemical expansion.

3. Thirdly, if a very thick layer on the order of greater than one-half inch of fiber blanket material is used, failure will occur for several additional reasons.

a. The refractory bricks will move out in a non-uniform way due to inadequate containment. Some will move out more than others due to differences in temperature, as well as different degrees of chemical reaction in each brick. The temperatures around the vessel are not uniform due to many reasons beyond the scope of these discussions. This will make the lining material unstable and the brick misalignment will create pathways for the smelt to escape to the back side of the bricks. This misalignment problem is well known among refractory designers and installers. The controlled crushable material used in the context of the present invention will alleviate the problems otherwise allowed by fiber blankets.

b. A thick fiber blanket will also not satisfy the thermal gradient criteria. The fiber blanket is too insulating. The temperature on the cold side of the blanket will be too

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high and will cause molten smelt to exist, which will freeze to a solid state in the blanket and defeat the purpose of the blanket as a compressible material.

c. A thick fiber blanket cannot be used behind skew blocks. A 1-1/2 inch thick blanket behind the skew block would cause the dome to fail structurally. For this reason, even the prior art felt materials are preferably not used behind skew blocks. Because the dome weighs 30 tons, no refractory designer/installer would risk supporting this weight on fiber blankets.

On the other hand, applicants' invention is unique because it is not a direct extension of the prior art as exemplified by Hyde. Applicants' approach provides a known and controllable resistance to the expansion of the brick due to chemical growth. This resistance provides stability to the lining. It also limits the radial inward displacement (growth) of the lining due to expansion resulting from the chemical reaction of the brick, by allowing the controlled outward movement. Applicants' approach also provides a high heat transfer rate because it provides little thermal resistance between the refractory material and the outer shell. Good heat transfer is necessary to freeze the smelt in the backup lining to prevent smelt leaks.

As a consequence, applicants have researched, understood and solved the problems caused by chemical growth of the refractory inner bricks resulting from their chemical conversion from alumina to sodium aluminate. As stated above, the chemical expansion that occurs is significantly greater than thermal expansion addressed in the prior art references such as Hyde. Applicants' invention provides a selectively crushable material that provides controlled resistance to the expansion of the refractory shell. Prior art thermal blankets do not provide controlled resistance to the thermal expansion, however, allow thermal expansion with negligible resistance. Applicants' invention solves the problem not recognized or understood by the art.

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Applicants' invention is therefore neither anticipated nor rendered obvious by Hyde or any of the other references cited in the parent application hereto.

The Examiner is therefore respectfully requested to examine the application, to allow the case, and pass it to issue.

If the Examiner has any questions regarding the foregoing, he is invited to call applicants' attorney at the number listed below.

Respectfully submitted,

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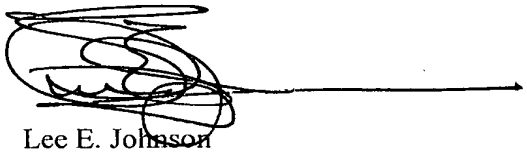

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